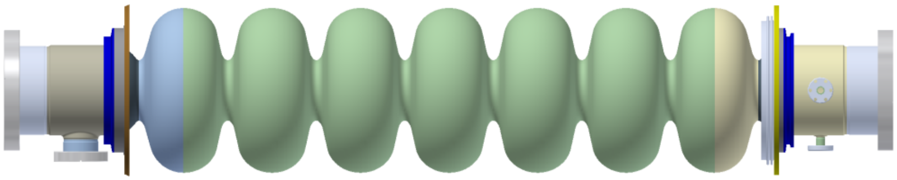
Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE)

Linac commissioning

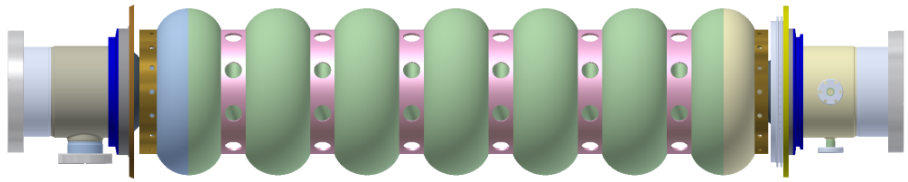
R. EICHHORN, CORNELL

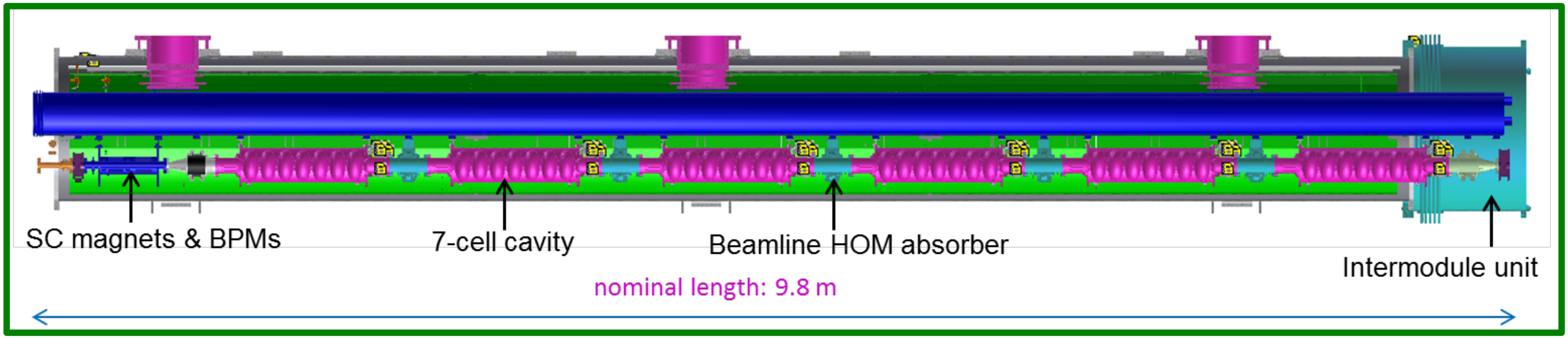
Paramters of the MLC

Un-stiffened Cavity



Stiffened Cavity





- Number of 7-cell cavities 6
- Acceleration gradient 16.2 MV/m
- R/Q (linac definition) 774 Ohm
- Qext 6.5×10^{7}
- Total 2K / 5K / 80K loads: 76W / 70W / 1500W
- Number of HOM loads 7
- HOM power per cavity 200 W
- Couplers per cavity 1
- RF power per cavity 5 kW
- Amplitude/phase stability 10^{-4} / 0.05° (rms)
- Module length 9.8 m

CLASSE facilities are operated by the Cornell Laboratory for Elementary Particle Physics (LEPP) and the Cornell High Energy Synchrotron Source (CHESS) with major support from the National Science Foundation.

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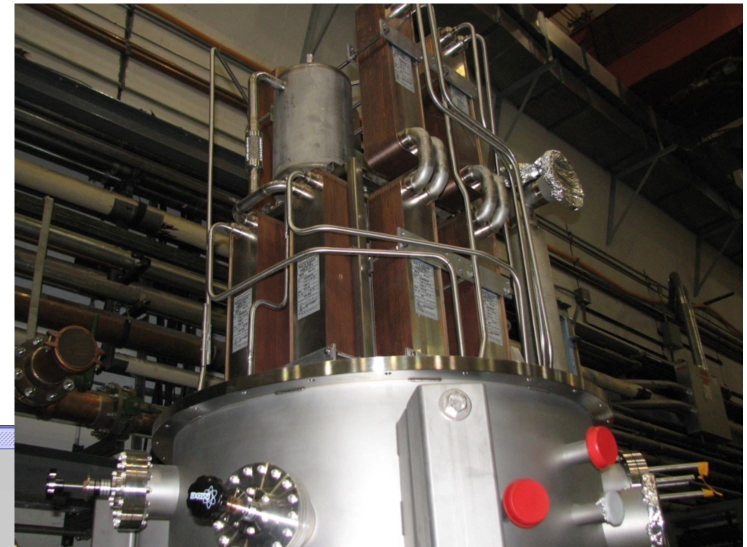
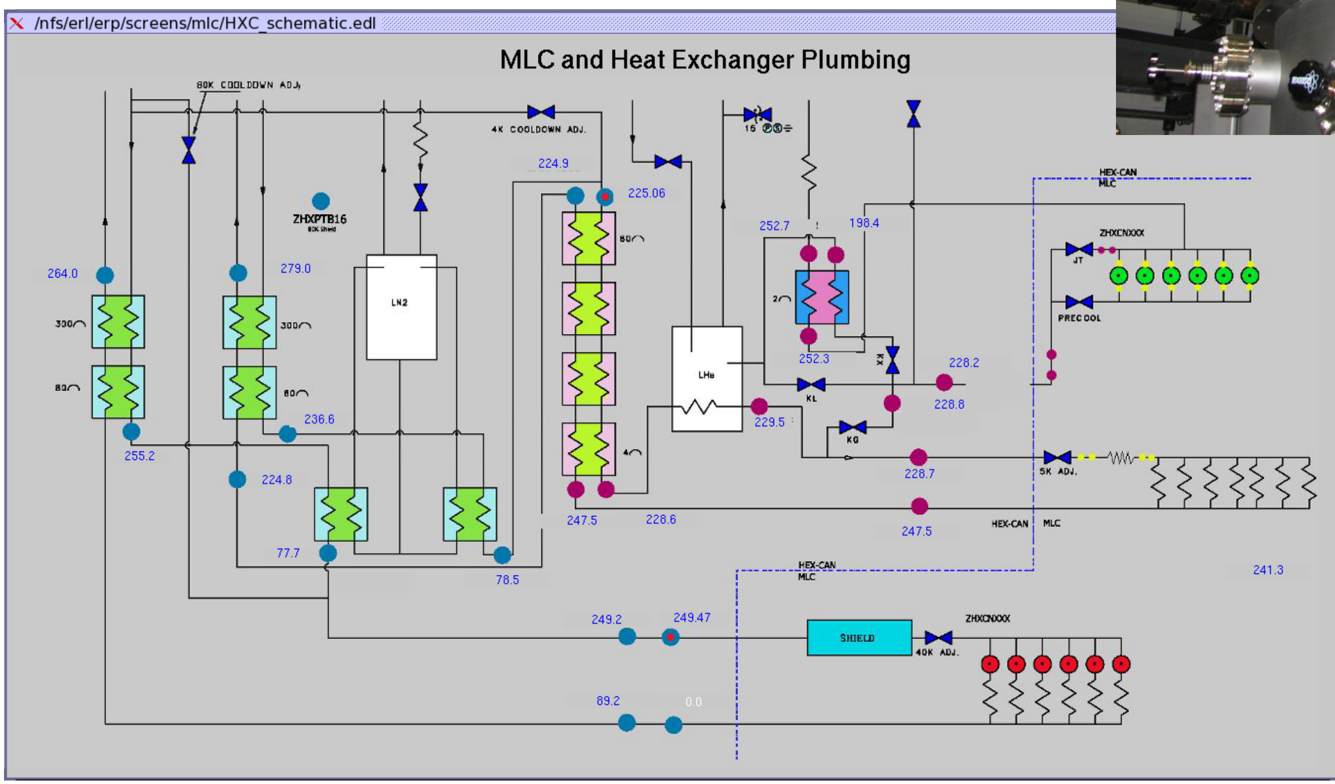
Preparation for cool-down

Heat-Exchanger can





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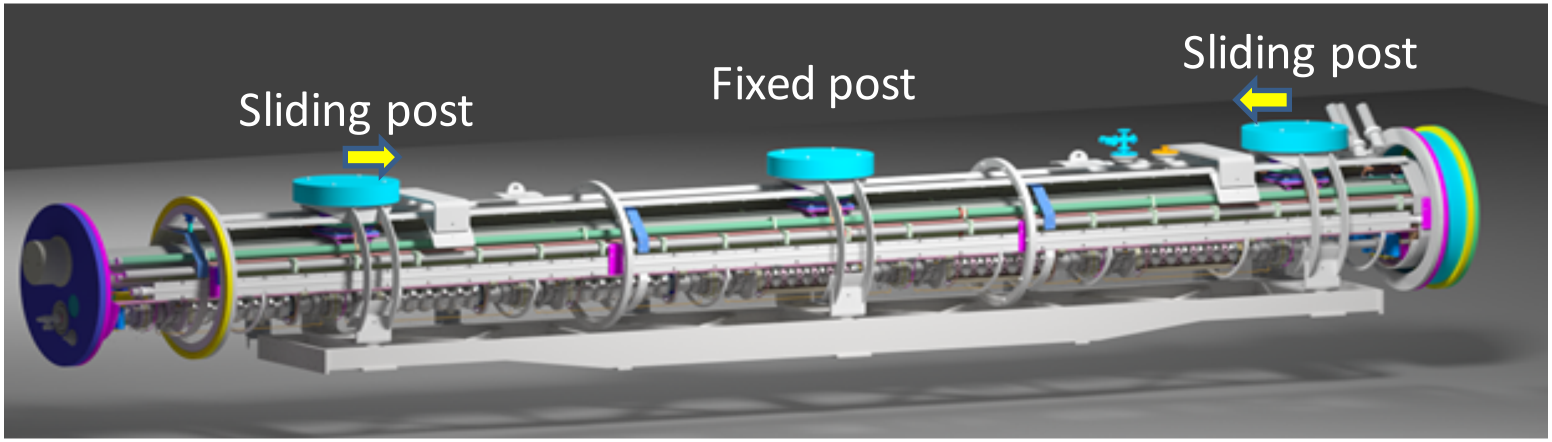
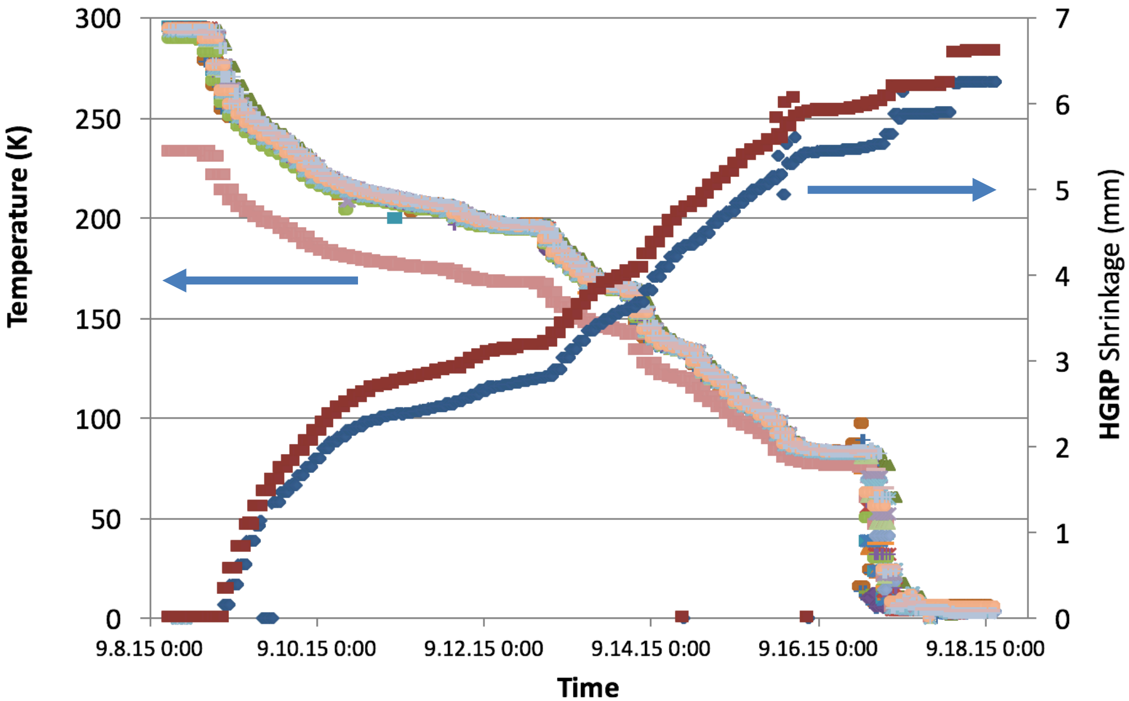
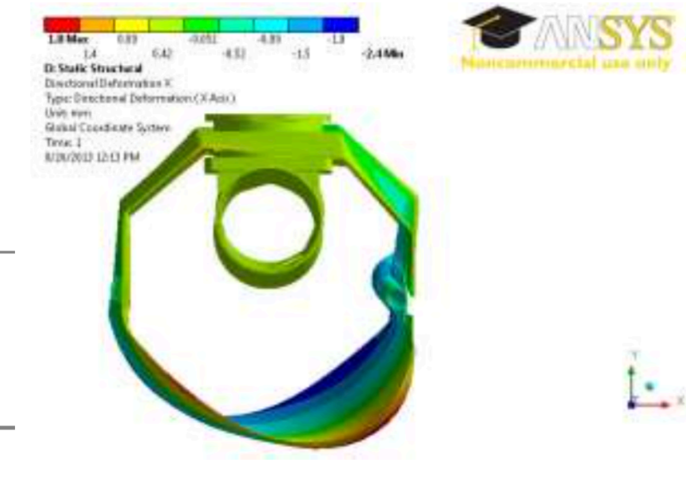
Cool-down temperatures and support post movement

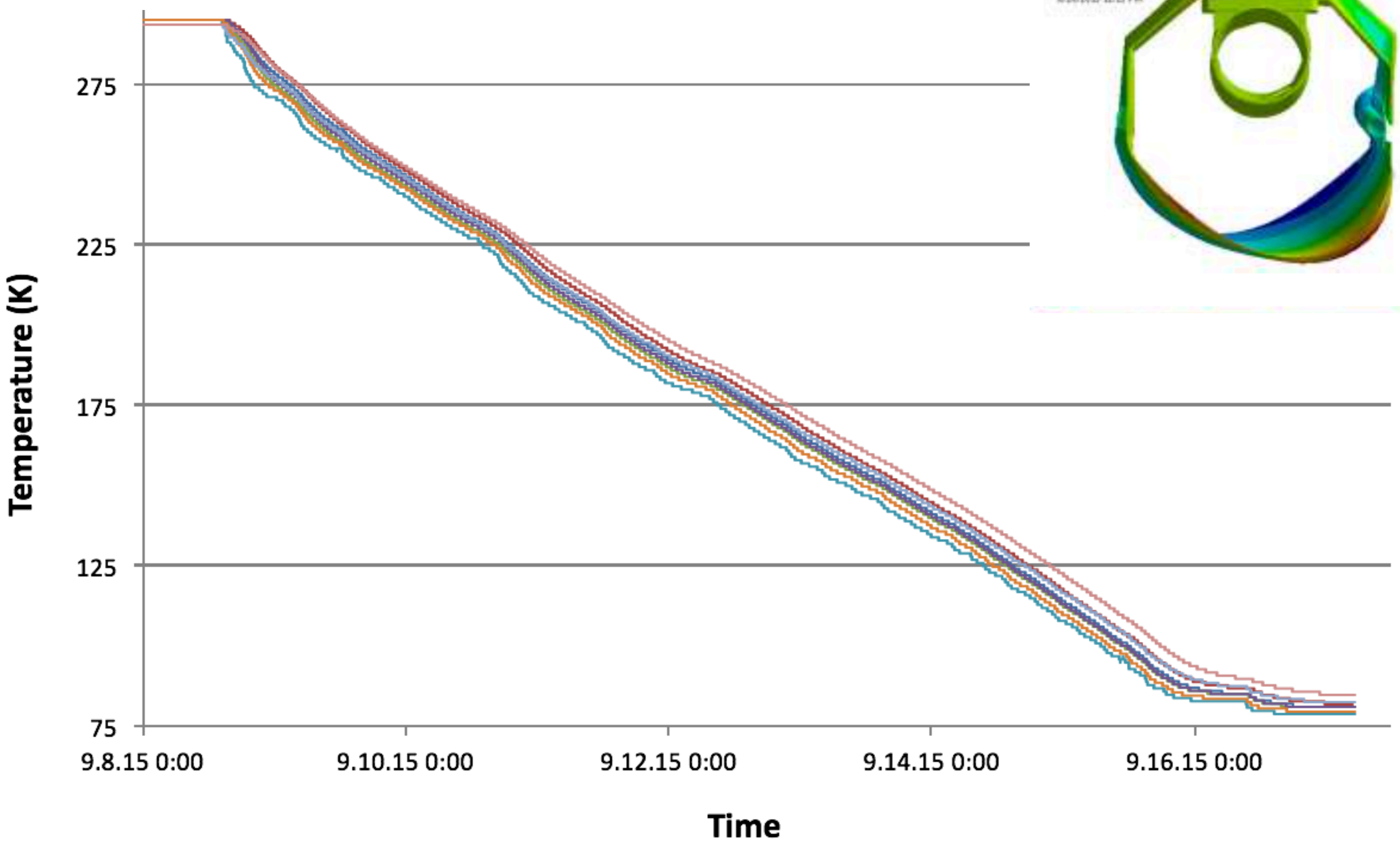




80 K Shield Cooldown

- Calculated max allowable temperature spread: 20 K
- Initial cool-down: $\Delta T=10$ K , leading to ~1K/h cool-down rate
- At 200 K we allowed $\Delta T=15$K resulting in 1.2 K/h





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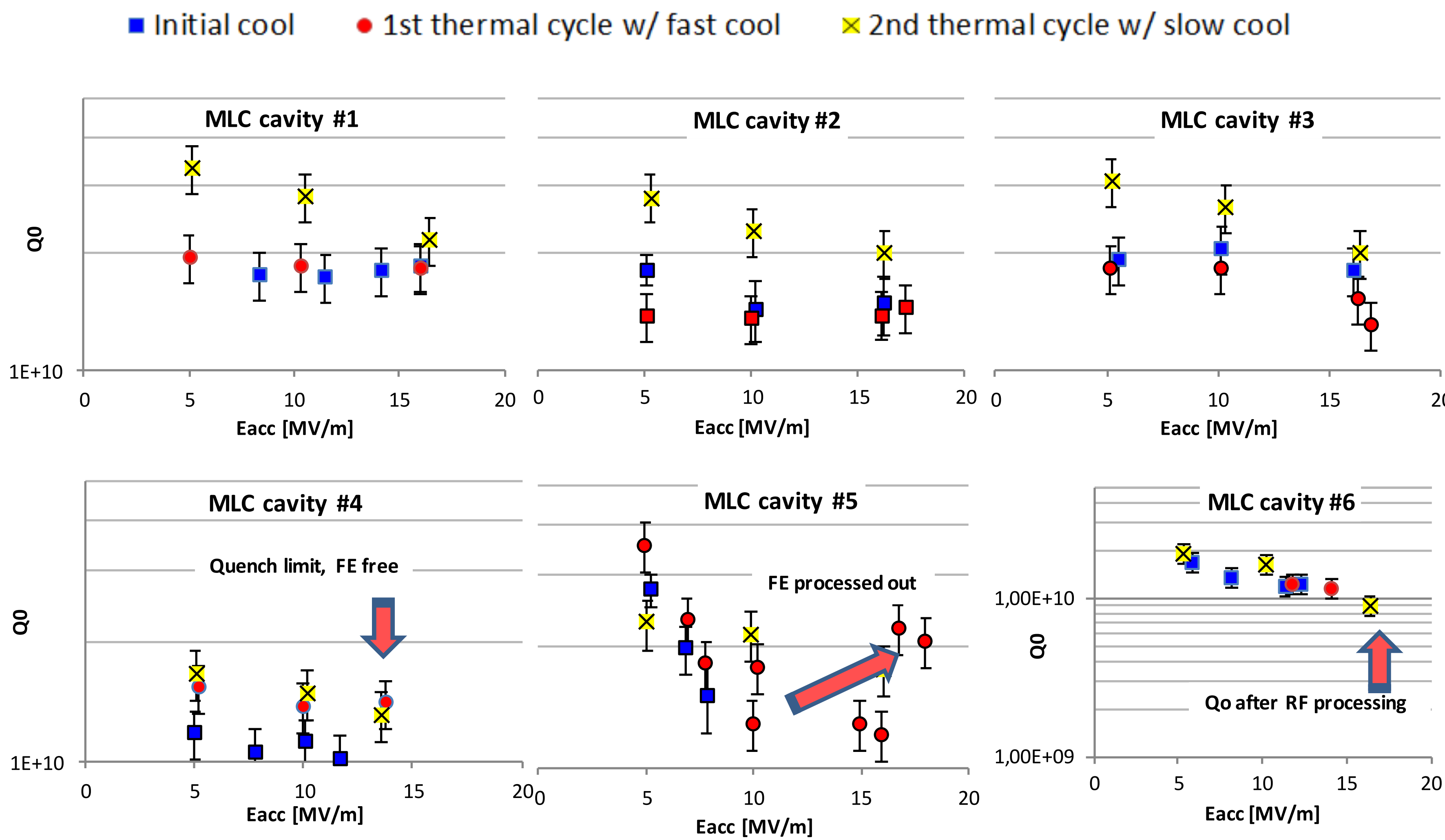
Cryo-Module
Cavity performance



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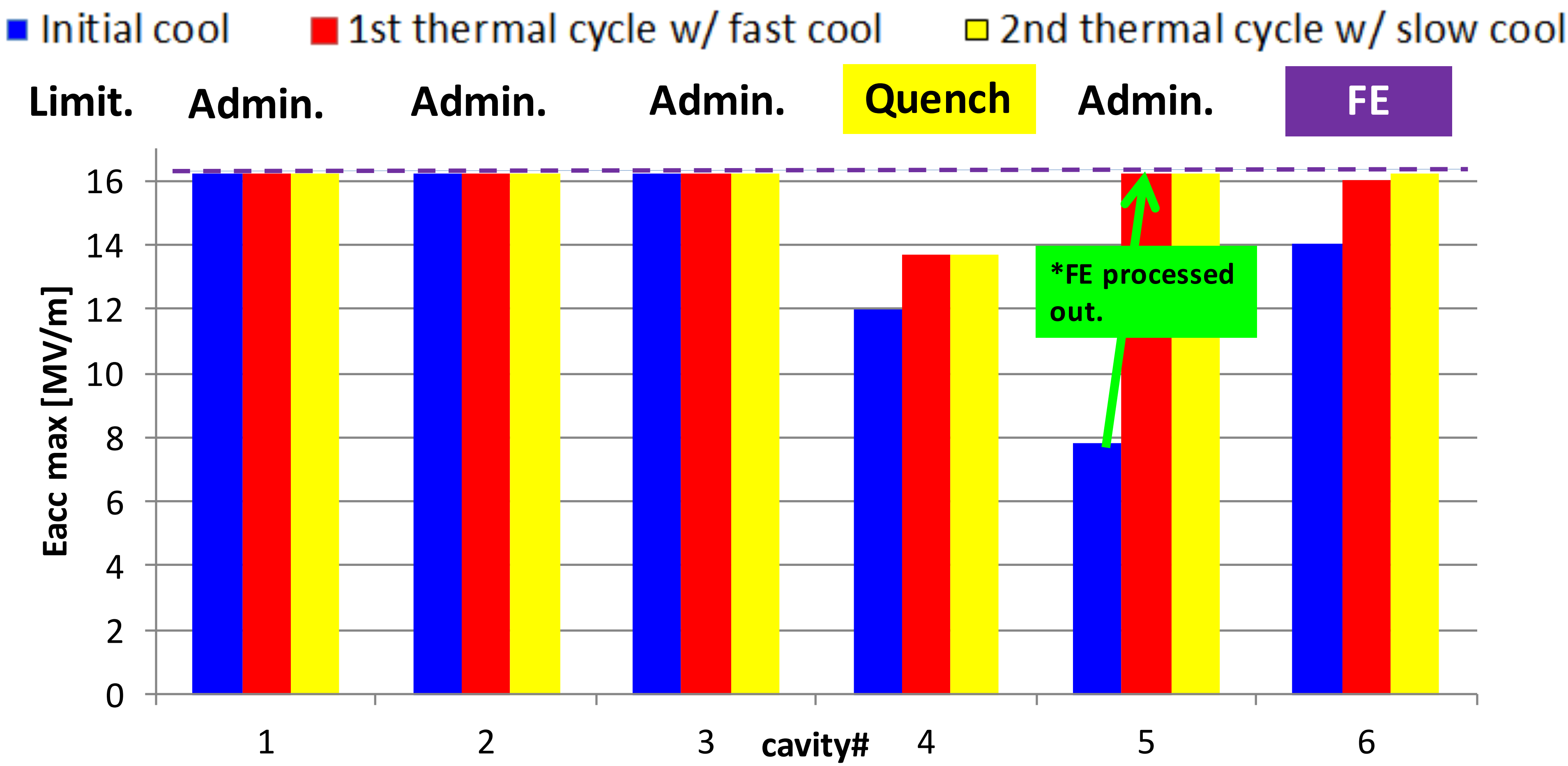
MLC Results: Max Fields at 1.8K



- 5 of 6 cavities had achieved design gradient of 16.2MV/m at 1.8K in MLC.
- Cavity#4 was limited by quench , FE free.

RF power requirements

- Forwarded power needed to maintain Vacc is given by

$$P_{forw} = \frac{V_{acc}^2}{4\cdot R/Q\cdot Q_L}\cdot\frac{\beta+1}{\beta}\left\{1+\left(2Q_L\cdot\frac{\Delta\omega}{\omega_c}+\frac{I_b R/Q\cdot Q_L}{V_{acc}}\cdot\Delta\phi\right)^2\right\}$$

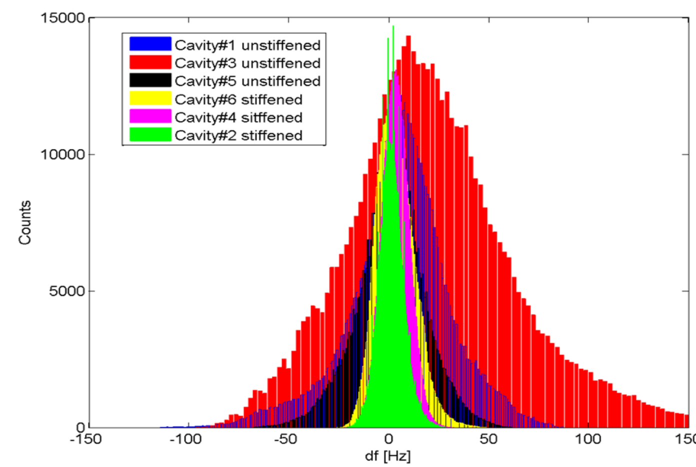
Power coupler design choice

microphonics

Energy recovery efficiency

- Module performance so far:

	Δf/Hz	Q_0 /10^{10}	Q_{ext}/10^7
Cavity #1	80	1.88	5.13
Cavity #2	15	1.98	5.38
Cavity #3	100	2.01	6.90
Cavity #4	20	1.45	5.67
Cavity #5	60	1.78	5.38
Cavity #6	20	1.91	6.14
Design	**10**	**2.0**	**6.5**



Microphonics

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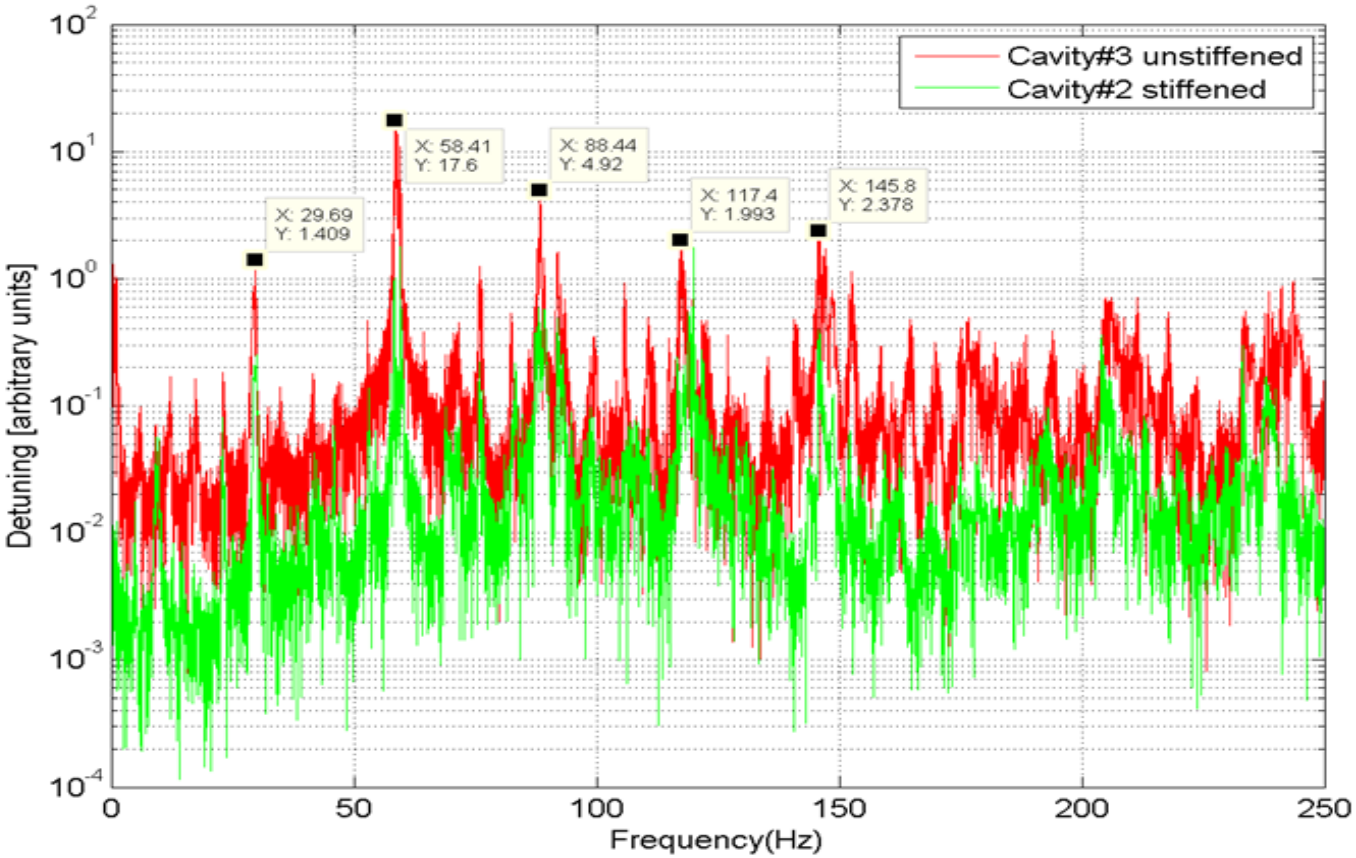
- Piezo pick-up data



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Identify and isolate the vibration sources

1) Pump Skid ON

80K flow was 7.5 g/s (high flow)

5K flow was 1.8 g/s

2) Pump skid Off

80K flow was 2.425 g/s (low flow)

5K flow was 1.6 g/s

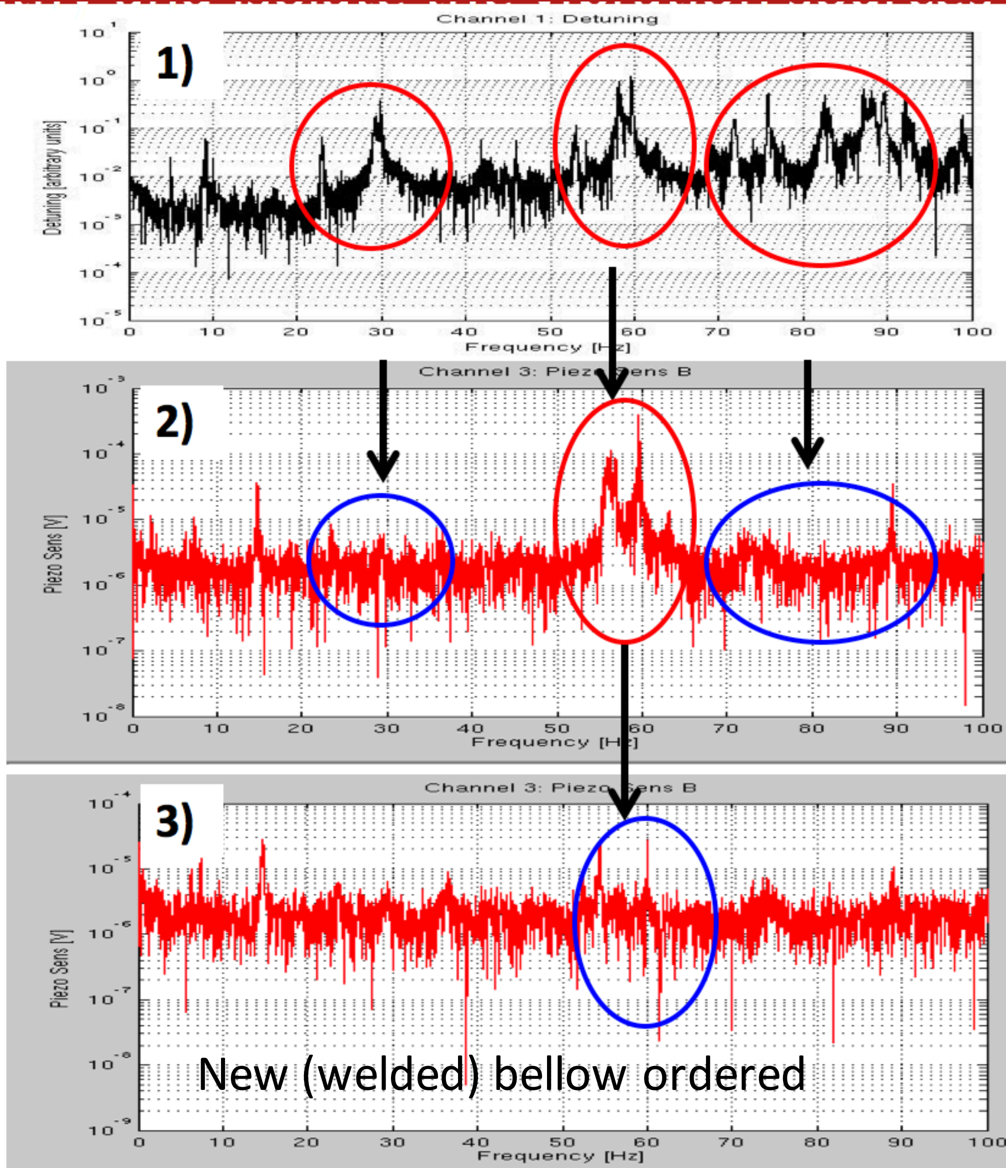
Insulation vacuum turbo pumps ON valve Open.

3) Pump skid Off

80K flow was 2.425 g/s(low flow)

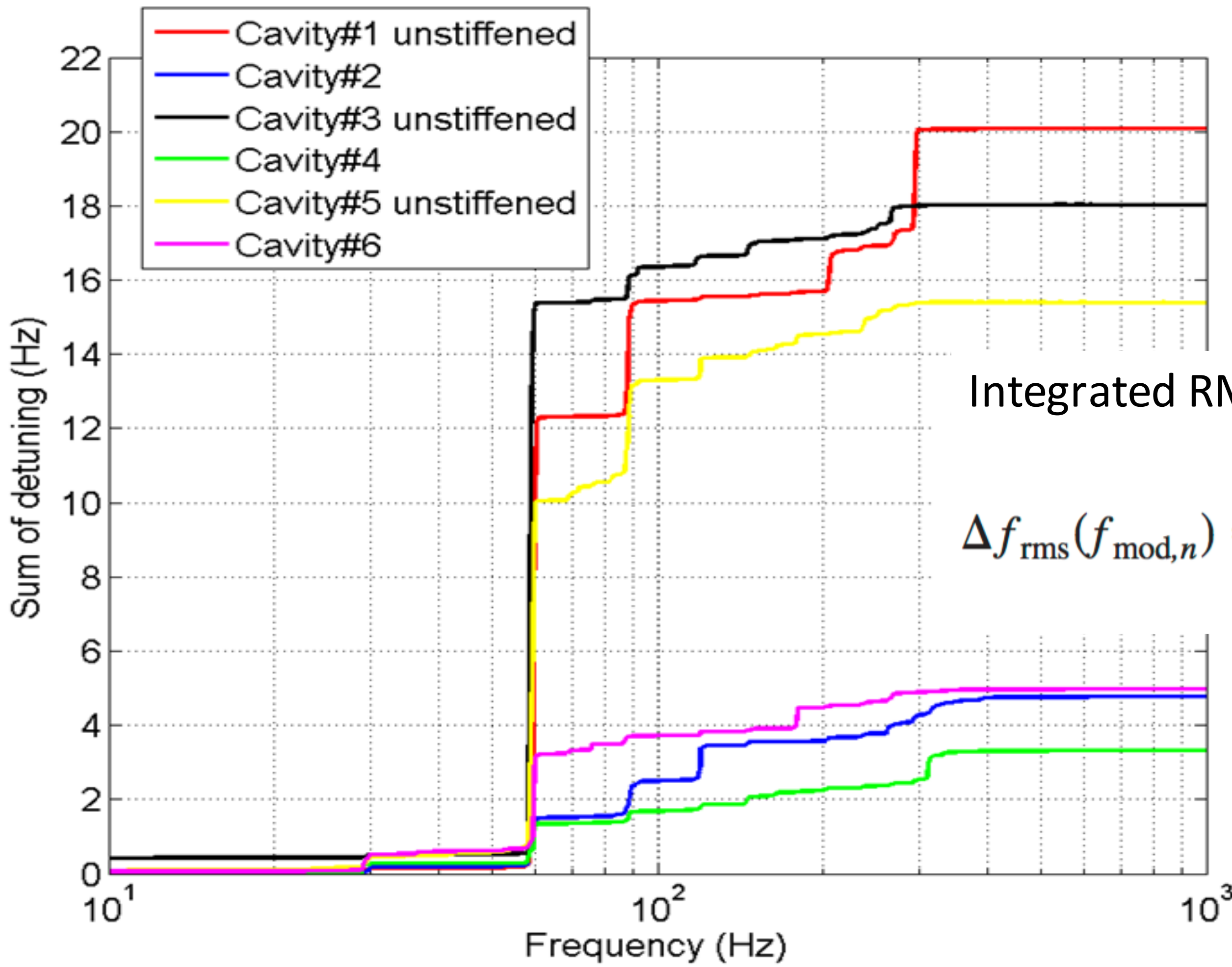
5K flow was 1.6 g/s

Insulation vacuum turbo pumps off, valve shut.



Mirophonics analysis

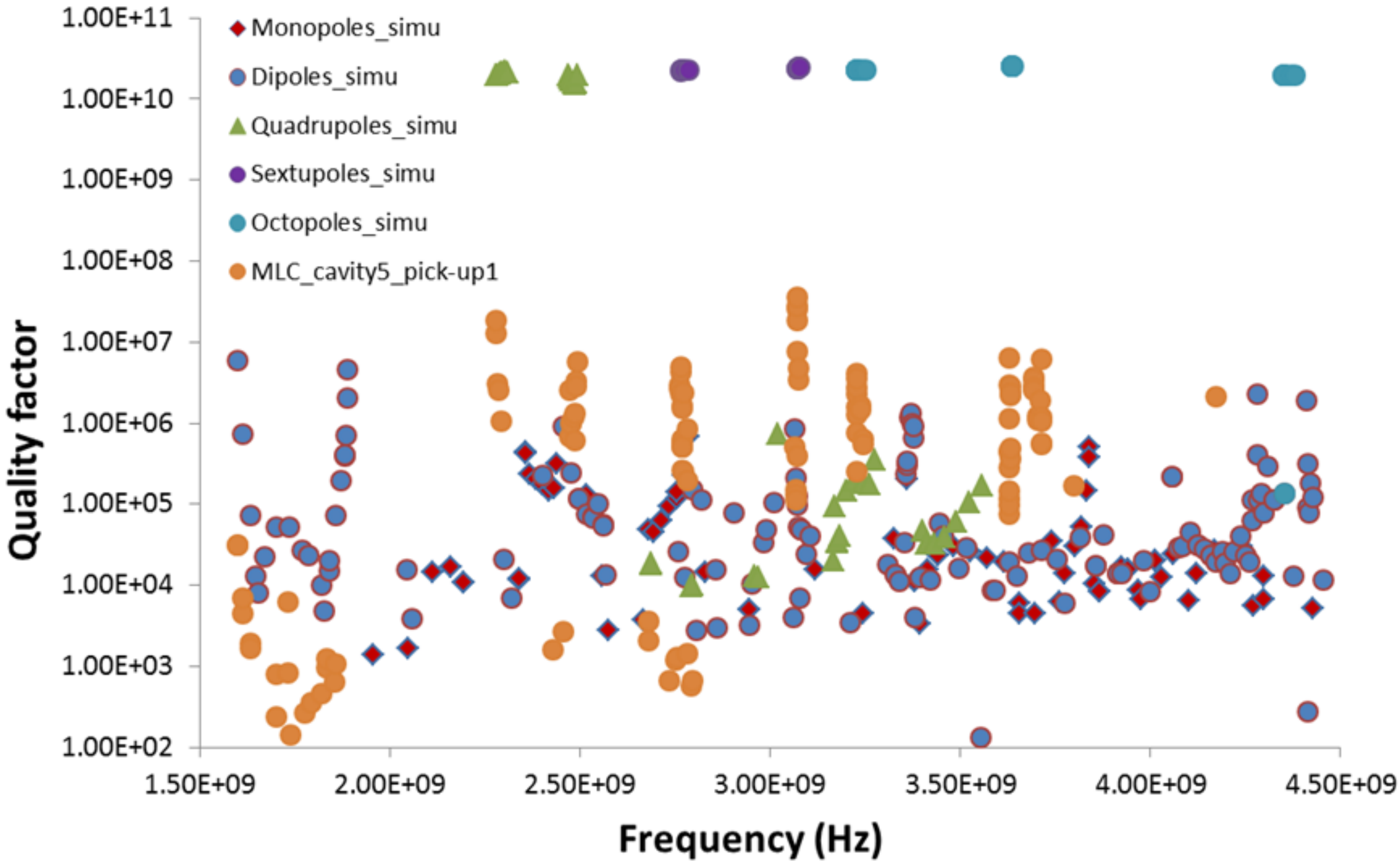
Best done using the LLRF system measuring absolute detuning



Integrated RMS detuning spectrum

$$\Delta f_{\text{rms}}(f_{\text{mod},n}) = \frac{\sqrt{\sum_{i=1}^{n} |[\mathcal{F}[\Delta f(t)]_i]|^2}}{\sqrt{2}}.$$

HOM Spectrum (Cavity #5)



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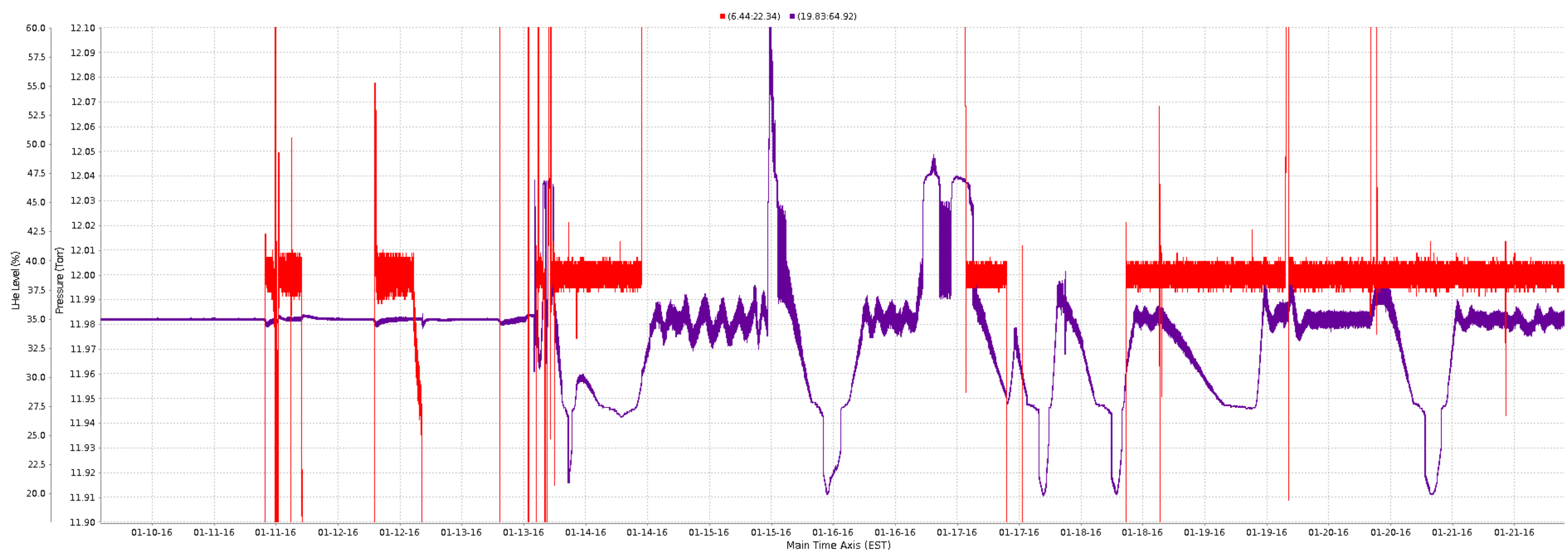
Pressure stability

- Initially up to 5 mbar variation (as a result of JT action)
- In steady state (JT fixed, lHe regulated by heater, controls optimized) we achieved less than 0.1 mbar



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Next steps

- Cooling down to 1.8 K again, re-instate running conditions
- Run LLRF and analyse free run data
- Analyse pressure sensor data (1.8 K system)

	Cajon Ultra Torr; Cajo
Transient Response (time constant):	8 msec
Diaphragm resonant frequency:	2700 - 5500- Hz depe

- Take more accelerometer data
- Add pneumatic dampers to pump-skids and other vibrations generators
- Plan for using full RF capabilities of the couplers (10 kW)
- Measure HOM spectra of the remaining cavities

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Questions?

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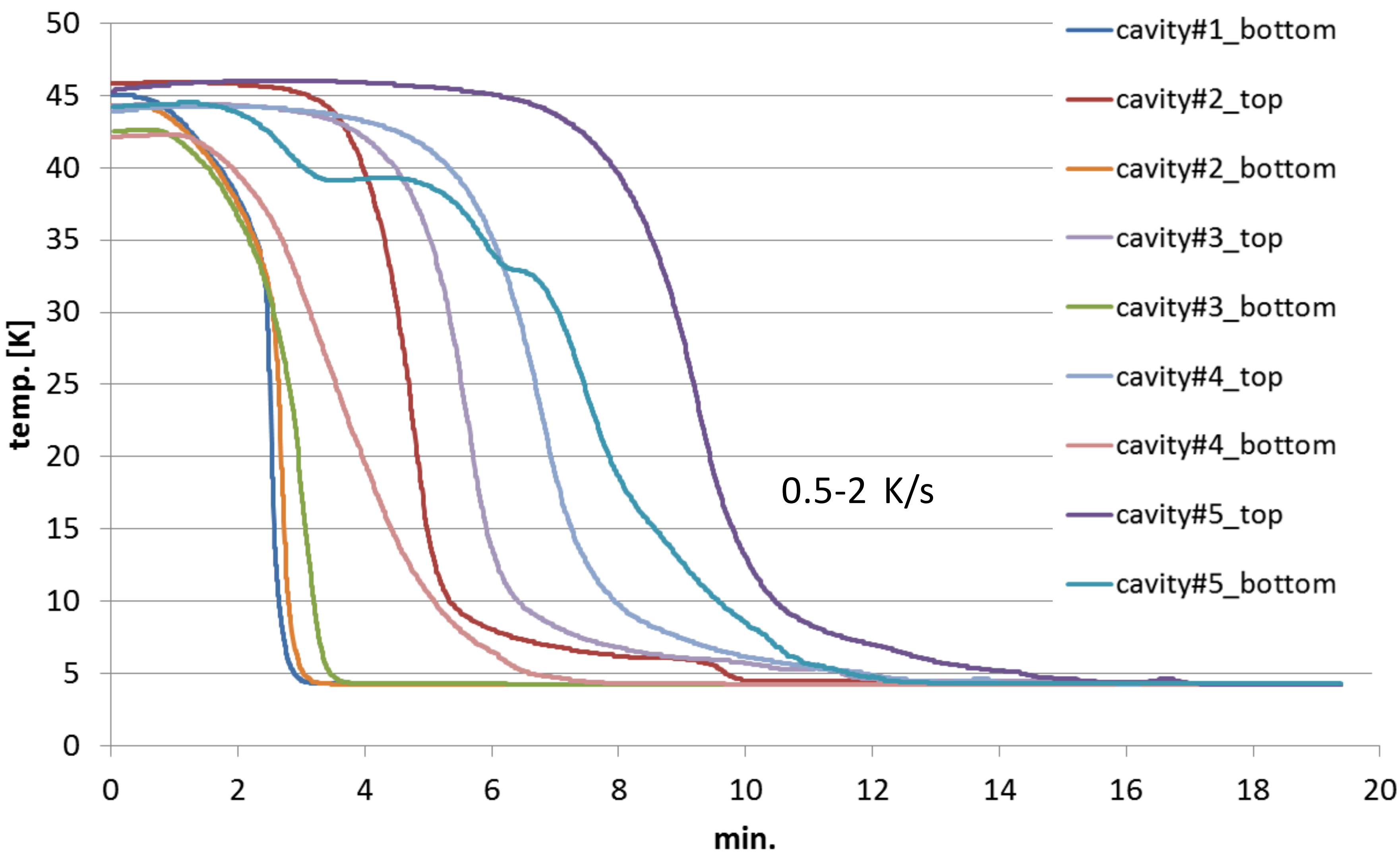
Fast Cool-Down



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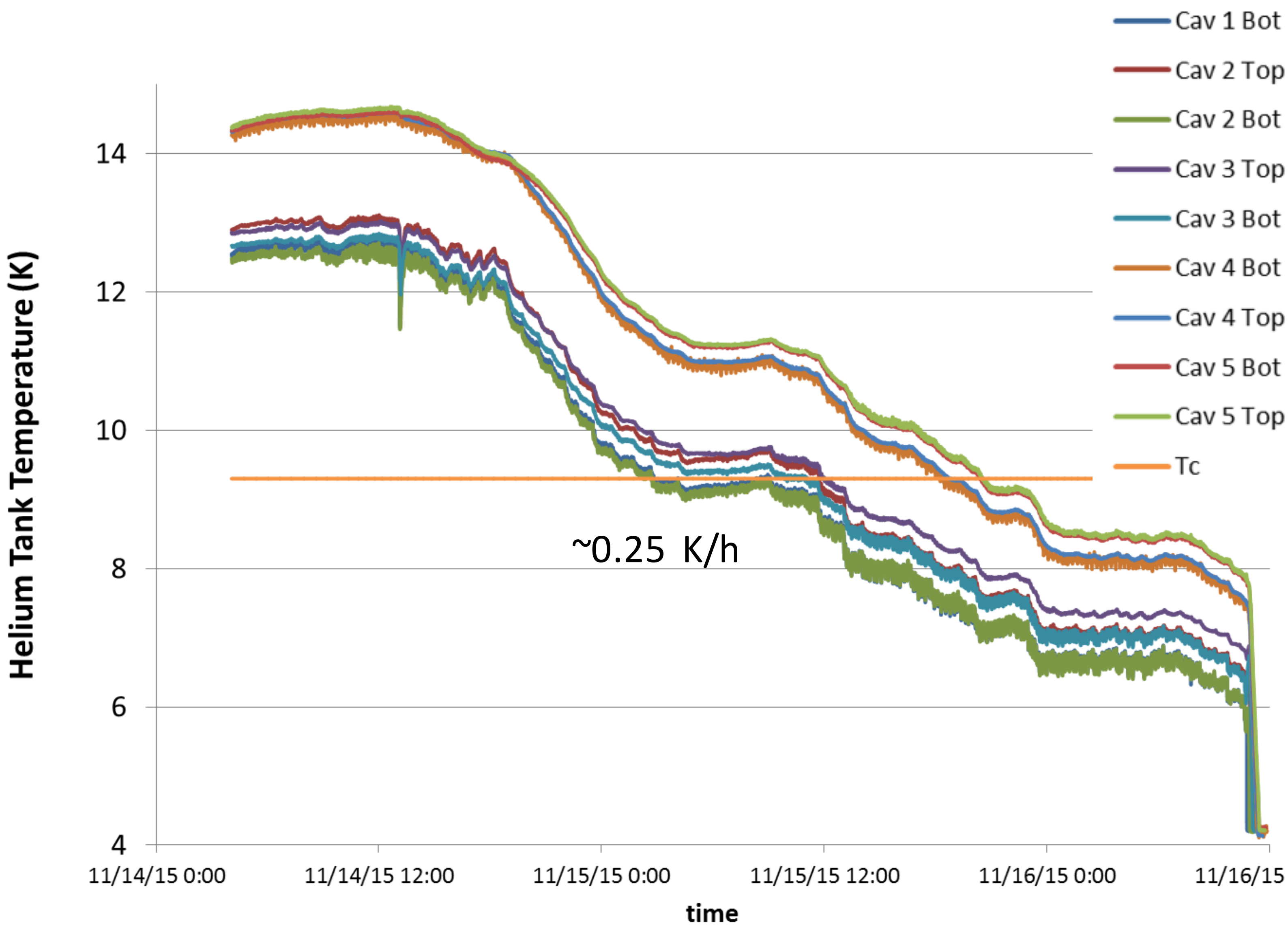
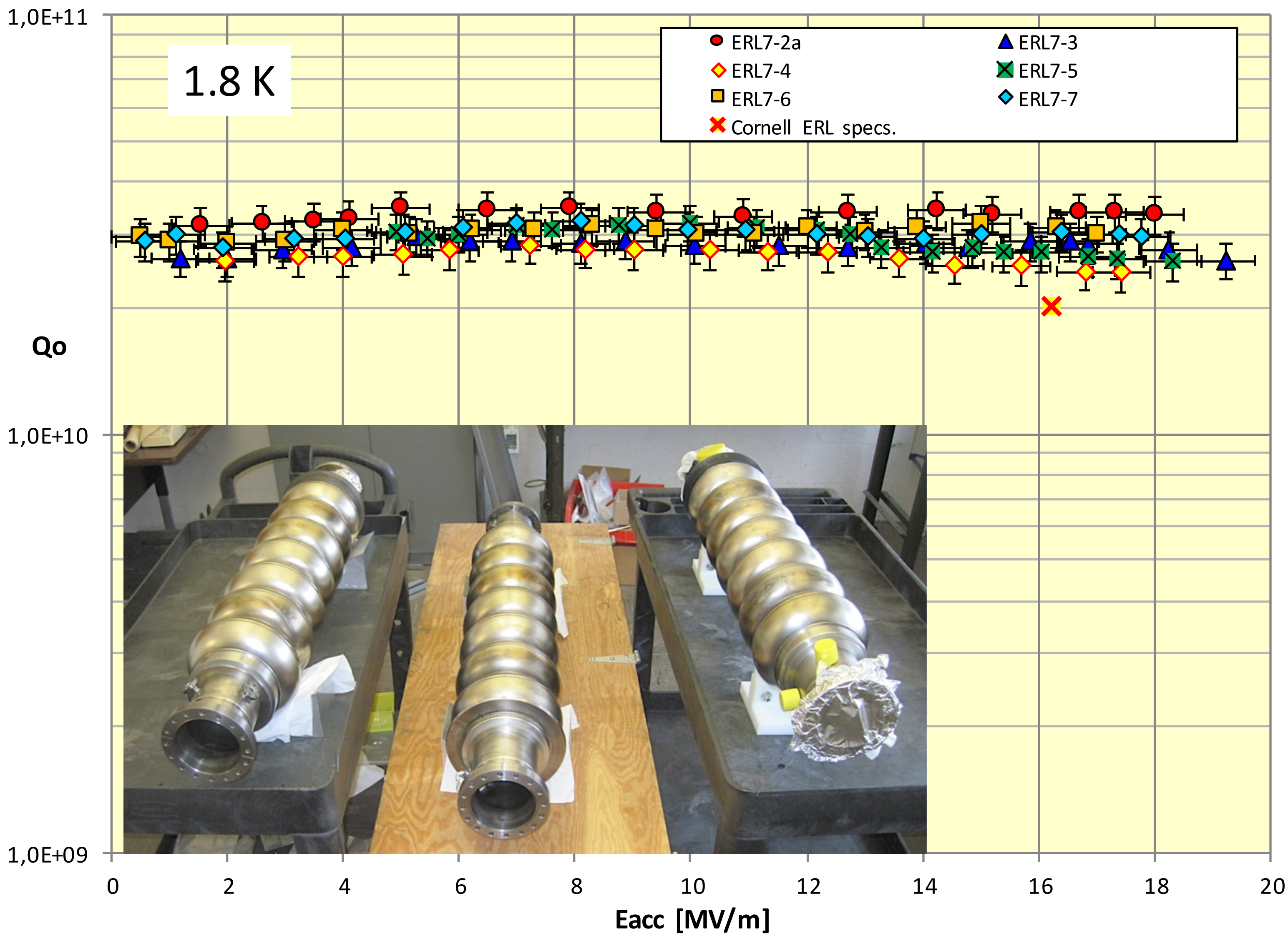
Slow cool-down



Vertical Cavity Test Results



Tuner Data

		Before tuning [MHz]	After tuning [MHz]	Tuning range	df/dp
Design		**1299.700**	**1300.0000**		
Cavity#1	ERL7-3, un-stiffened	1299.525	1300.0000	+470kHz	29 Hz/mbar
Cavity#2	ERL7-5, Stiffened	1299.724	1300.0000	+270kHz	11 Hz/mbar
Cavity#3	ERL7-4, Un-stiffened	1299.650	1300.0002	+340kHz	35 Hz/mbar
Cavity#4	ERL7-7, Stiffened	1299.615	1299.996	+381kHz	13 Hz/mbar
Cavity#5	ERL7-2a, Un-stiffened	1299.677	1300.000	+323kHz	25 Hz/mbar
Cavity#6	ERL7-6, Stiffened	1299.554	1299.939	+385kHz	13 Hz/mbar

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